NASA Planetary Science Division's Instrument Development Programs, PICASSO and MatISSE

James R. Gaier

NASA Planetary Science Division

NASA Planetary Science

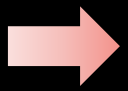
Strategic Goal: ***Advance scientific knowledge of the origin and history of the solar system, the potential for life elsewhere, and the hazards and resources present as humans explore space.***

It seeks to answer five fundamental questions:

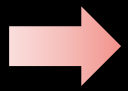
- How did the Sun's family of planets and minor bodies originate?
- How did the solar system evolve to its current diverse state?
- What are the characteristics of the solar system that led to the origin of life?
- How did life begin and evolve on Earth and has it evolved elsewhere in the solar system?
- What are the hazards and resources in the solar system environment that will affect the extension of human presence in space?

Instrument Development Strategy

I have this crazy idea
TRL 1-3



I can make it work
TRL 4-6



How did we ever do without it?
TRL 7-9

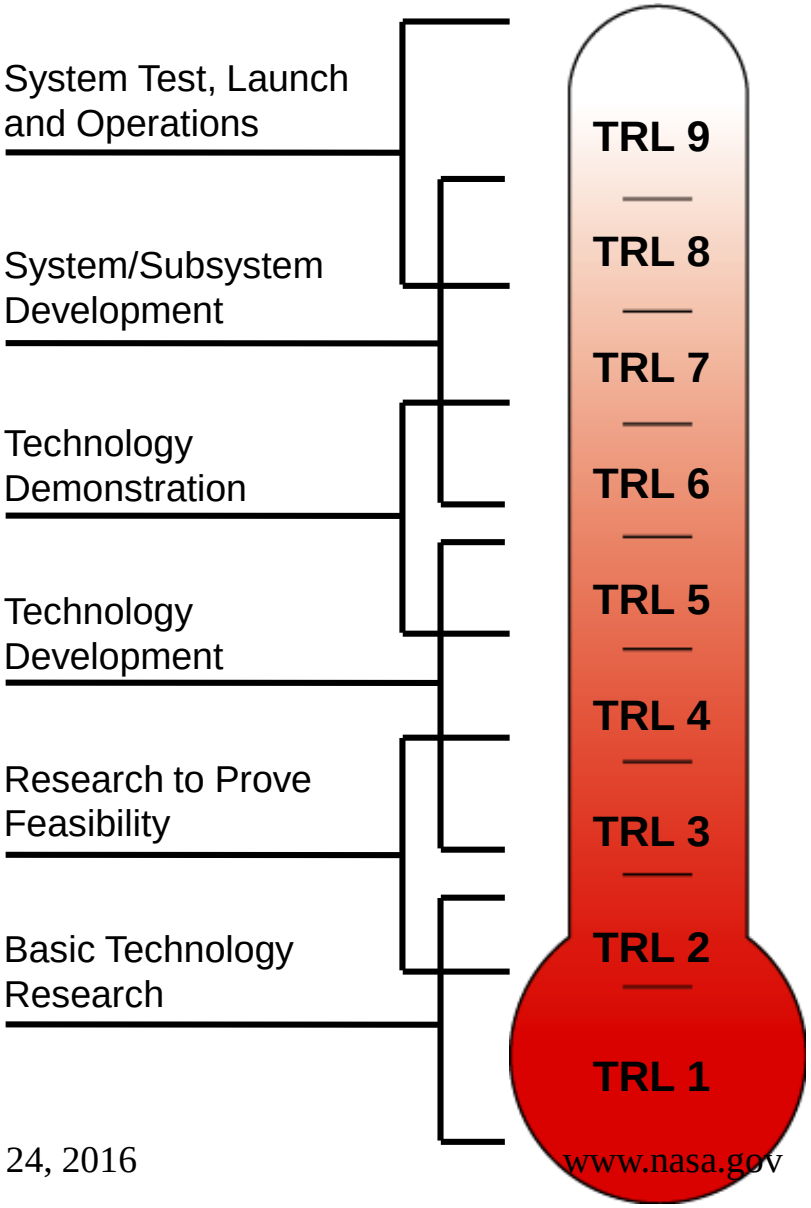
Planetary Instrument Concepts Advancing Solar System Observations (PICASSO)

- **PICASSO** supports the development of spacecraft-based instrument systems that show promise for use in future planetary missions
- **Program goal** to develop low TRL technology to feed MatISSE, etc.
  - science instrument feasibility studies
  - concept formation
  - proof of concept instruments
  - advanced component technology
- **Program objectives** to develop new technologies that significantly improve instrument measurement capabilities for planetary science missions
- **Proposals** are typically sought every year.
- **The budget** is ~$3.5 M per year.
  - Average award ~ $250 - $300K/year
  - Typically ~ 12 awards

Maturation of Instruments for Solar System Exploration (MatISSE)

- **MatISSE** supports the maturation of spacecraft-based instrument systems that show promise for use in future planetary missions
- Program goal to develop instrument to point where they can be proposed to flight programs
  - Must address specific science objectives
  - Retire major technological risk
- Program requires higher level of oversight
  - Quarterly reviews
  - Site visits
  - External reviewers
- **Proposals** are typically sought on even numbered years
- **The budget** is ~$6 M per year.
  - Average award ~ $1.0M/year
  - Typically ~ 6 awards

PICASSO Entry TRL's 1-3



Actual system "flight proven" through successful mission operations

Actual system completed and "flight qualified" through test and demonstration (Ground or Flight)

System prototype demonstration in a space environment

System/subsystem model or prototype demonstration in a relevant environment (Ground or Space)

Component and/or breadboard validation in relevant environment

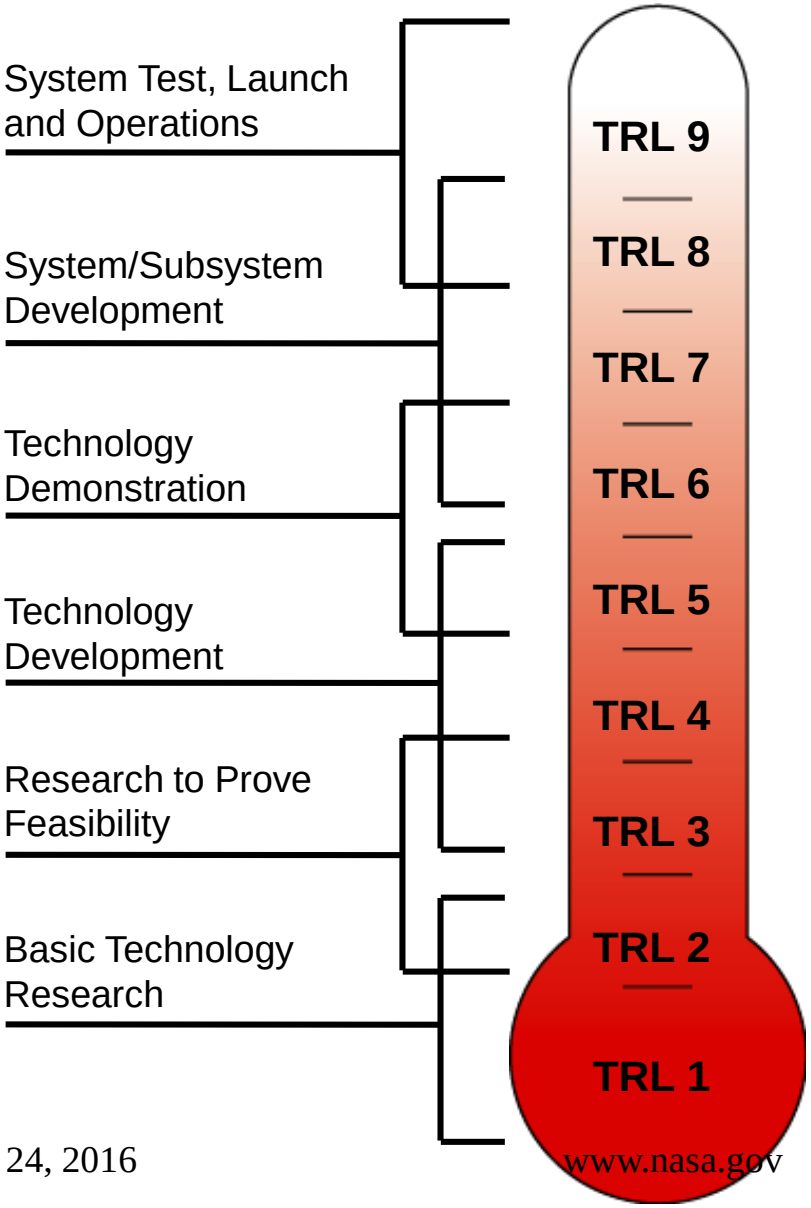
Component and/or breadboard validation in laboratory environment

Analytical and experimental critical function and/or characteristic proof-of-concept

Technology concept and/or application formulated

Basic principles observed and reported

MatISSE TRL's 4-6



Actual system "flight proven" through successful mission operations

Actual system completed and "flight qualified" through test and demonstration (Ground or Flight)

System prototype demonstration in a space environment

System/subsystem model or prototype demonstration in a relevant environment (Ground or Space)

Component and/or breadboard validation in relevant environment

Component and/or breadboard validation in laboratory environment

Analytical and experimental critical function and/or characteristic proof-of-concept

Technology concept and/or application formulated

Basic principles observed and reported

TRL Summary

TRL's are quantized
- TRL 2-3 does not exist
- If the technology is between 2 & 3, it is 2

PICASSO
- Entry TRL must be 1, 2, or 3
- Advance the TRL at least 1 level.

MatISSE
- Entry TRL 3 or higher
- Advance the TRL to 6

Evaluations

- All compliant proposals are discussed (no triage)
- There is only one PI
- Proposers receive only the final panel review, not the individual ones
- No response to previous reviews required
- Training components are not required
- An overall score of "Good" is fundable
- The review panel does not rank proposals
  - Done later by in conjunction with NASA program leads
  - Selection Official does final selection

The prime directive…

- Reviewers do not guess, infer, interpolate, extrapolate, or read between the lines.

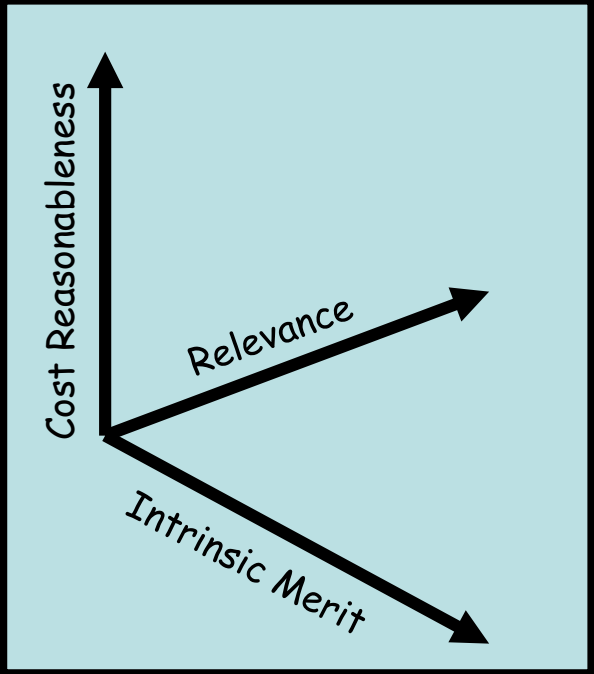
- They evaluate only what is written in the proposal.

Evaluation Criteria

- **Intrinsic Merit**
  Scientific/technical merit (including qualifications of team and TRL assessment)

- **Relevance** to program (assuming success as proposed)

- **Cost Reasonableness** (for what they proposed)



Intrinsic Merit

- **Questions to consider:**
  - Can the proposed instrument concept achieve the proposed measurement goal?
  - Can the development achieve the progress proposed?
  - Does the proposal acknowledge potential pitfalls and propose alternatives?
  - Does the team have the necessary expertise?

Relevance

- **Assume that everything works as proposed.**
- Question to consider:
  - How compelling and articulate is the argument presented in the proposal for the relevance of the proposed development to NASA's and PSD's strategic goals?
  - Are specific NASA planning documents cited?
    - Decadal Survey
    - NASA Science Plan
    - Etc.

Cost Reasonableness

- Questions to consider:
  - Are the resources requested (FTEs, travel and supply costs, etc.) reasonable for the scale and type of work proposed?
  - Is the budget clearly described and justified
    - All major sub-contracts or sub-awards?
    - Quotes for items > $5,000?
  - Detailed Work Plan
    - Milestones
    - Schedule
    - Budget
- "Cost reasonableness" ≠ "bang for buck."

Strengths and Weaknesses

- Each proposal has strengths and weaknesses
- Strengths and weaknesses may be major or minor.
  - "Major" and "minor" are fairly broad categories so not all "majors" are equally important.
  - Some major weaknesses, though, are ***fatal flaws***.

Strength and Weakness

Major strength distinguishes it and provides a justification for selection

Major weakness is a deficiency that is not correctable in a subsequent negotiation process *A proposal with a fatal flaw in any evaluation category is not selectable.*

- **Minor Strength and Weakness**
  - Comments of value to the selecting official or the proposers which are noteworthy.
  - Minor weakness is correctable if addressed early during period of performance

Early Career Fellowship (ECF)

- Intended to help make planetary science post-docs more attractive to hiring institutions.
- Application is literally checking a box
  - Additional information supporting ECF request in the CV portion of the proposal
  - Accomplishments to date
  - Current research
  - Ideas for future research directions
  - How future research will support planetary science research goals

ECF Process

- Proposal must first be selected to be eligible
  - Does not affect proposal selection
  - ECF candidate must be recommended by review panel

- Separate application process
  - When offered tenure-track equivalent positions can apply for up to $100k in start-up funds over and above proposal award

Historical Success

- Virtually all US instruments on planetary probes started in PSD instrument development programs
  - Nearly all instrument PI's were funded by instrument development programs
  - Instruments rapidly becoming smaller and more capable
- With your help, PICASSO and MatISSE are on track to continue that success